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RUBBER LABORATORY IN BRAZIL

In an effort to develop its natural resources to the highest point, the Government of Brazil is establishing several regional agricultural institutes; one of these is located at Belem, Para. Through the State Department, the Bureau was requested to assist the Brazilian Government in equipping this laboratory and developing a research program.

Under a provision of an Act of Congress, which provides for the loan of technical experts to South and Central American countries, Norman Bekkedahl, of the Bureau's rubber section, has gone to Belem, where he will serve as chief of the Rubber Technology Division, of the Instituto Agronomico do Norte. He has, as his assistant, Fred L. Downs, formerly rubber research chemist on the staff of the American Steel & Wire Co. Before leaving the United States, Dr. Bekkedahl placed orders for the equipment needed to set up a modern rubber research and testing laboratory. When completed, it will be the only one of its kind serving the United Nations in the tropics and at the source of the rubber supply.

Dr. Bekkedahl is well qualified for this important post. He has done a great deal of work on the physicochemical and thermodynamic properties of

rubber, as described in previous numbers of this Bulletin. In 1938 he was appointed by the President to act as delegate for the United States at the Tenth International Congress of Chemistry, at Rome. He served as delegate of the National Academy of Sciences at the same conference and at the Thirteenth Conference of the International Union of Chemistry. He represented the Bureau at the International Rubber Technology Conference in London.

Mr. Downs served as a student assistant in the Bureau's rubber section and as chemist with the Thermoid Rubber Co., where he became familiar with testing and control work. In 1935 he joined the staff of the electrical cable division of the American Steel & Wire Co., and was concerned with the development and testing of rubber insulation. He has had wide experience in the handling of synthetic rubbers and plastic materials.

DENSITIES OF SYNTHETIC RUBBERS

Synthetic rubber can be produced under conditions which are much better known and more subject to control than those involved in the production of natural rubber. It is logical, then, to measure its density with greater precision, in the hope of being able to ascribe significance to the variations found

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when one sample is compared with another. The densities of different samples of natural rubber show variations as great as 1 or 2 percent, and have never been correlated with the origin or subsequent treatment of the rubber.

The precise measurement of densities of synthetic rubbers forms the subject of a paper by Lawrence A. Wood, Norman Bekkedahl, and Frank L. Roth in the November number of *Industrial and Engineering Chemistry*, and which will also appear as RP1507 in the December *Journal of Research*. The paper gives the method of preparing specimens in suitable form, the details of the actual measurements by the method of hydrostatic weighings, and the results obtained for 18 varieties of synthetic rubber, including almost all of those now manufactured in the United States.

Samples of synthetic rubbers as received from the manufacturer were never found to be in a form suitable for precise measurements of the density. Even where there appeared to be no entrapped air and the surface seemed to be relatively smooth, molding produced specimens yielding higher and much more consistent values. A vacuum chamber was designed so that the specimen could be heated and molded under vacuum into a sheet about $\frac{1}{8}$ inch thick. The density of specimens weighing about 1 gram each, which had been cut from this sheet, was determined. The values obtained with different specimens from the same sample rarely differed from each other by more than 0.05 percent. The measurements were made soon after molding, because some rubbers recover and develop roughened surfaces and vacuoles which bring about a decrease in the apparent density.

Unvulcanized Buna S, prepared in a laboratory polymerization with a minimum quantity of materials other than butadiene and styrene, was found to have a density at 25° C of 0.9291 g/cm³. Corresponding values for butadiene-styrene copolymers produced on a commercial scale were as follows: Firestone Buna S, 0.9358; U. S. Rubber Co. Buna S, 0.9369; Standard Oil (N. J.) Buna S, 0.9390; Chemigum IV, 0.9391; Hycar O. S.-20, 0.9385; and Hycar O. S.-30, 0.9303 g/cm³. The densities of other common varieties of synthetic rubber were found to be as follows: Neoprene CG, 1.2307; Neoprene E, 1.2384; Neoprene FR, 1.1406; Neoprene GN, 1.2290; Chemigum I, 1.0135; Hycar O. R., 0.9992; Perbunan, 0.9684; Thiokol RD, 1.0564; Thiokol A, 1.5983; Thiokol FA, 1.3298; and Butyl B-1.45, 0.9175 g/cm³.

COMBINATION OF WOOL WITH ACIDS IN MIXTURES

A theory of dyeing should explain the nature of the attraction of dyes for textile fibers, how the dyes go on, and what makes them stick so that they resist washing. It should also aid in understanding the effect on the transfer of the dye from bath to fibers of such factors as the amounts of each acid, dye, and salt present in a complicated solution, the dyebath.

Papers already published have provided a basis for such a theory by demonstrating that different strong acids, including acid dyes, combine with wool to very different extents. These differences have been interpreted in terms of the combination of wool with the anions of acids as well as with hydrogen ions, the combination with each anion being governed by its own distinct and characteristic affinity. In Research Papers RP1510 and RP1511 in the December number of the *Journal of Research*, Jacinto Steinhardt, Charles N. Fugitt, and Milton Harris, Research Associates of the Textile Foundation, extend this analysis on the basis of measurements of the amounts of each of two acids which combine with wool when a dye acid or salt and various second acids are present in mixtures. It is shown that the two anions compete with each other for combination with the fibers, so that the amounts of each combined depend not only on the amounts initially present but on their respective affinities for wool, as previously determined.

The bearing of these results on the theory of acid dyeing is discussed, with special reference to the factors promoting the attainment of level and solid application of dye to the fibers.

PHASE-EQUILIBRIUM STUDIES INVOLVING POTASH COMPOUNDS OF PORTLAND CEMENT

In the December *Journal of Research* (RP1512), William C. Taylor describes an investigational program designed to determine the manner in which K₂O is combined in portland cement clinker. In general, this involves a series of phase-equilibrium studies of binary and ternary systems. The systems to be included are chosen, from time to time, by examining the products of reaction between a known clinker compound and a newly established compound in a system just studied. Specifically, the research on K₂O in clinker has been conducted as follows: The compound K₂O·Al₂O₃ was shown to exist in the sys-

tem $K_2O-CaO-Al_2O_3$; following studies showed that $K_2O-Al_2O_3$ and $4CaO-Al_2O_3-Fe_2O_3$ form a simple binary system with no additional compound; in ensuing studies, however, it was found that $K_2O-Al_2O_3$ reacts with $3CaO \cdot SiO_2$ and with $2CaO \cdot SiO_2$ in the formation of a ternary potash-lime-silica compound; the composition of this potash-lime-silica compound was established as $K_2O \cdot 23CaO \cdot 12SiO_2$, by a study of the system $K_2O \cdot CaO \cdot SiO_2-2CaO \cdot SiO_2$; this compound was shown to be stable in the presence of $3CaO \cdot Al_2O_3$ and $4CaO \cdot Al_2O_3-Fe_2O_3$; the present study of the system $K_2O \cdot 23CaO \cdot 12SiO_2-CaO-5CaO \cdot 3Al_2O_3$ was then undertaken to determine if any other potash compound might exist in clinkers composed of K_2O , CaO , Al_2O_3 , and SiO_2 , and comparable to portland cement clinker in composition.

The ternary system $K_2O \cdot 23CaO \cdot 12SiO_2-CaO-5CaO \cdot 3Al_2O_3$ was investigated and a phase diagram constructed. The only solid phase, other than the components observed in the system, was the compound $3CaO \cdot Al_2O_3$.

Studies of the products of reaction between $K_2O \cdot 23CaO \cdot 12SiO_2$ and $CaSO_4$, and also of those produced when clinker raw mixtures containing both K_2O and SO_3 are heated, showed that K_2O combines preferentially with SO_3 to form K_2SO_4 . It was found that any K_2O in excess of the amount required by the SO_3 in the formation of K_2SO_4 , combines with CaO and SiO_2 to form $K_2O \cdot 23CaO \cdot 12SiO_2$. No evidence was obtained of any potash compounds other than K_2SO_4 and $K_2O \cdot 23CaO \cdot 12SiO_2$ in clinkers composed of K_2O , CaO , Al_2O_3 , Fe_2O_3 , SiO_2 , and SO_3 .

At elevated temperatures, the molten K_2SO_4 appeared to be immiscible with the other liquid phase formed from the components of the clinker and, consequently, seemed to have no effect on the products of crystallization. Upon cooling, K_2SO_4 crystallized extremely rapidly.

Crystals of K_2SO_4 were identified in several commercial portland cement clinkers.

No reaction of either K_2SO_4 or $K_2O \cdot 23CaO \cdot 12SiO_2$ with MgO was observed, which indicates that the presence of MgO does not affect the manner in which K_2O is combined in clinker.

HIGH-EARLY-STRENGTH CEMENT CONCRETES

Ten-year compressive-strength tests have now been completed on concretes made with 12 high-early-strength cements, for which the results up to 1

year were given in J. Research NBS 14, 723 (June 1935) RP799. The concretes were of three different cement-water (C/W) ratios, five initial temperature conditions, and four curing conditions.

As reported by L. Schuman in the December Journal of Research (RP-1508), concretes stored in damp air generally continued to gain strength up to 10 years. Concretes stored in the air of the laboratory had about the same strengths at 10 years as at 28 days. The strengths at ages after 28 days were not appreciably affected by the initial temperatures, which varied from 70° to 110° F. However, the usual variation in strength with C/W ratio persisted up to 10 years. For damp-cured 1:2:4 concrete of C/W ratio=1.50 (7.5 gal of water per 94 lb bag of cement) the compressive strengths at 10 years were generally between 4,000 and 5,000 lb./in.² For concrete of the same proportions, and a C/W ratio of 1.73 (6.5 gal per bag), strengths of over 6,000 lb./in.² were attained for 8 of the 12 cements.

Present-day cements, even of the moderate-heat type, are shown to be capable of giving concrete strengths in 1 month at least equal to those for a 1910 cement at 10 years; present-day (1941) high-early-strength cements may give strengths at 1 month exceeding the 10-year strengths reported in Research Paper RP1508.

RECOMMENDED BUILDING CODE REQUIREMENTS FOR NEW DWELLING CONSTRUCTION

In a report entitled "Recommended Building Code Requirements for New Dwelling Construction With Special Reference to War Housing," just issued in the Building Materials and Structures series, a representative committee drawn from the Federal agencies most concerned with housing, presents its recommendations for improved requirements.

Building code requirements are frequently criticized on the ground that they call for excessive amounts of materials and discourage the introduction of new methods of construction. Such criticism is pointless unless improved requirements can be offered that will have the effect of correcting the conditions mentioned.

Building code requirements can be legally effective only when they call for the minimum that is necessary for safety and health. This places such requirements in a different class from other standards, which properly take

into consideration expected life, comfort, livability, good taste, and other matters that are socially and economically desirable but cannot be legally required. An appreciation of this distinction should help to clear up some of the confusion that exists regarding apparent inconsistencies between building standards and building code requirements.

The recommended requirements contained in the report apply to single- and two-family houses and to multiple dwellings of limited height, and cover such matters as fire resistance, light and ventilation, exits, strength of construction, and chimneys and fireplaces. In general, good practice is required, certain well-recognized standards and specifications being cited as acceptable evidence that this is being followed. Specific dimensions and other details are given where necessary. The intent is to assure safety and health, and at the same time to permit the greatest possible flexibility in design and construction.

The committee recognizes that emergency conditions limit the availability of certain materials, require stringent economy in the use of others, and make the use of substitutes necessary in some cases. However, the committee has not considered it practicable to write building code requirements in terms of a severely restricted list of materials based on temporary shortages or to suggest details about substitutes in the code itself. Such matters are covered more flexibly and efficiently by general code provisions, supplemented by regulations that can be put into effect or withdrawn in accordance with fluctuating conditions. The subjects of new materials and methods of construction are treated in a general way, providing for their acceptance on submittal of satisfactory evidence that they are suitable. In order to conserve space in the code itself and to widen the field of choice of materials and methods, the report contains an appendix giving information on various acceptable ways of meeting specific code requirements and references to source material.

The report, which is designated as BMS88, is recommended to those seeking the advice of Federal agencies as to proper building code requirements in areas not now having such requirements. It is also offered for consideration wherever local building codes are being adopted or revised. It is believed that such a document can provide a continuing service through which the experience of Federal agencies and the

results of Federal research can be made continuously available to local governmental authorities. Periodical revision is planned, and criticism and suggestions for improvement are invited. Copies of the report are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is 20 cents.

SUBSTITUTES FOR METAL IN HEATING DUCTS

Restrictions against the use of metal, particularly galvanized and tinned sheets, make necessary the use of substitutes. Unfortunately, no other readily available material has the same characteristics from the viewpoint of the sheet-metal worker. A number of fire tests with proposed substitutes have been recently conducted at the Bureau.

A substitute that can be worked with the same tools and technique would find more ready acceptance by the trade, because any changes required in the procedure of fabrication and erection will usually work a hardship by slowing up the job. For these reasons the thin, pliable sheets have found favor, although some of the rigid boards may have superior structural strength and durability. Since fire safety requirements are lower for returns than for the hot-air ducts, different materials for the two kinds of ducts are used in many installations.

Among the pliable boards offered are several composed of a felt base with high melting point asphalt saturant and coating. Others are of similar composition for the core with facings of asbestos paper. These are combustible. Other pliable boards have paper boxboard or pressboard cores with asbestos paper facings. Some of these are rated "Combustible" or "Slow-burning", and others "Fire Retardant", as tested according to the procedure outlined in Federal Specification SS-A-118 for prefabricated acoustical units, to which reference is made for testing methods and classification requirements. The incorporation of bituminous materials to lower absorption will usually increase flammability. Fire retardant treatment of pressboard or boxboard cores makes for increased safety from flame spread.

Cement-asbestos boards have many characteristics that make them suitable for duct walls, although they are not readily worked into turns, branches, and other complicated fittings. In one system of fabrication, the edges of the board are mitered and cemented together with an adhesive, after which paper tape is

applied to bind the corners on the outside. Another system employs grooved strips of flameproofed wood for corner members, and a third employs metal corner strips. All of these require some metal for fittings and unusual conditions.

A substitute for galvanized metal suitable for ducts or duct fittings recently placed on the market consists of pickled iron sheets coated with a high-melting-point compound of fatty acid pitch containing a high percentage of inert mineral filler.

This coating is covered with mica dust, which gives the sheet a gray color and a greasy feel. The technique and tools for working this material are the same as for galvanized metal except that preparation for soldering requires the removal of the coating from the areas to be joined. It is probable that this material will be acceptable to sheet-metal workers for use in lieu of the galvanized steel usually employed. The tests have indicated that only materials classed as "Incombustible" or "Fire Retardant" should be used for hot-air-supply ducts, with those of the latter classification at not less than 6 feet from the heating plant if liquid or solid fuels are employed. Material for return ducts may be of lower classification with respect to fire safety, but combustible materials should not be used within 3 feet of the heating plants.

OXYGEN REQUIREMENTS AT HIGH ALTITUDES

Normal persons become markedly less efficient at altitudes of 10,000 to 15,000 feet and collapse at around 20,000 feet when breathing air, but when breathing supplemental oxygen, they can ascend to much greater altitudes without danger of collapse.

In an article by W. A. Wildhack in the December number of the *Journal of the Aeronautical Sciences*, theoretical equations are developed to determine what concentrations of oxygen must be breathed at any altitude to maintain the "oxygen equivalent" of air at selected altitudes—I. e., the same alveolar oxygen pressure. The partial pressures of water vapor and carbon dioxide are taken into account, as well as the variation of the pressure of carbon dioxide with the alveolar oxygen pressure.

Six curves are given on a chart showing the oxygen concentrations required at any altitude to maintain the oxygen equivalent of air at sea level, and at altitudes of 5, 10, 15, 20, and 25 thou-

sand feet. Altitudes of 33.8, 40, and 46 thousands feet with pure oxygen are equivalent to air at sea level, 10, and 20 thousand feet, respectively.

It is shown that these equivalents are nearly independent of the assumptions as to the state of physiological adaptation, and should be applicable to all individuals.

TESTING GEIGER-MÜLLER COUNTERS

The Geiger-Müller counter is one of the most sensitive devices now available to physicists for detecting radiation from radioactive materials. It is also used extensively in the study of cosmic rays. Up to the present time it has been customary for individual scientists to prepare their own Geiger-Müller counters. This has led to a great variety of methods of manufacture, each claimed to be superior to the other. However, but little opportunity has existed for actual comparisons.

Few methods have been available to test the performance of these tube counters, but in RP1509 in the *Journal of Research* for December, F. J. Davis and L. F. Curtiss describe such a testing instrument. This determines quite accurately whether the pulses from a tube counter correspond in separation to that expected when the counter is exposed to a source of radiation (radioactive substance) which emits rays distributed in time according to the laws of probability. This instrument is called an "interval selector," since it records the number of intervals between pulses less than some chosen interval. The chosen interval may be varied between 0.0001 and 0.2 second. In addition, the instrument records the total number of pulses, so that the expected number under any set of conditions may be computed mathematically. If the observed number of pulses in the chosen interval agrees with the computed number, the counter satisfies one requirement for proper operation. It is then safe to assume that no spurious pulses (pulses not resulting from the radiation) are generated by the counter itself.

The authors have used this newly developed instrument to study the behavior of Geiger-Müller tube counters filled with a mixture of alcohol vapor and argon gas, as well as amyl acetate vapor and argon gas. They have found that this type of counter will give a time response to the radiation if fairly simple directions are followed in its preparation; moreover, some of the difficulties which have been reported in pre-

paring this type of counter have now been removed. Since the vapor type of counter requires a very simple vacuum-tube amplifier for operation (when compared with counter tubes using permanent gases alone) it is to be expected that these simplified manufacturing and testing procedures will result in its wider use.

It is now possible, in the opinion of the authors, to prepare Geiger-Müller counters of the alcohol-argon type that can be calibrated in the same manner as any other instrument. By the use of such calibrated counters, measurements in different laboratories may be compared quantitatively. This has not been possible in many instances heretofore. The authors have counters of the vapor type which have been in use for over 2 years with no essential changes of characteristics. It is evident, therefore, that the vapor type of counter is reasonably permanent when properly prepared.

NEW AND REVISED PUBLICATIONS ISSUED DURING NOVEMBER 1942

Journal of Research²

Journal of Research of the National Bureau of Standards, volume 29, number 5, November 1942 (P1502 to RP1506, inclusive). Price 30 cents. Annual subscription, 12 issues, \$3.50.

Building Materials and Structures Reports²

[Persons who wish to be notified of new publications in the Building Materials and Structures series as soon as they are available should write to the Superintendent of Doc-

uments, Government Printing Office, Washington, D. C., asking that their names be placed on the special mailing list maintained by him for this purpose.]

BMS88. Recommended building code requirements for new dwelling construction with special reference to war housing. Report of Subcommittee on Building Codes, Central Housing Committee on Research, Design, and Construction. Price 20 cents.

Simplified Practice Recommendation²

R179-42. Structural insulating board (vegetable fiber). (Supersedes R179-41). Price 5 cents.

Technical News Bulletin²

Technical News Bulletin 307, November 1942. Price 5 cents. Annual subscription, 50 cents.

RECENT ARTICLES BY MEMBERS OF THE BUREAU'S STAFF PUBLISHED IN OUTSIDE JOURNALS³

Method for analyzing the gasoline fraction of petroleum, with preliminary results on East Texas and Oklahoma crudes. Frederick D. Rossini, Beveridge J. Mair, Alphonse F. Forziati, Augustus R. Glasgow, Jr. and Charles B. Willingham. Preprint of paper before 23rd annual meeting, Am. Petroleum Institute (50 West 50th St., New York, N. Y.) (November 10, 1942).

Plastics, Gordon M. Kline. Annual report, Smithsonian Institution (Washington, D. C.), p. 225 (October 1941). Factors influencing austenitic grain size. T. G. Digges and S. J. Rosenberg. Metal Progress (7301 Euclid Ave., Cleveland, Ohio) 42, 608 (October 1942).

² Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents a year; Journal of Research, \$3.50 a year (to addresses in the United States and its possessions and to countries extending the franking privilege; other countries, 70 cents and \$4.50, respectively).

³ These publications (unless otherwise stated) are not obtainable from the Government. Requests should be sent direct to the publishers.

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